

Extraction of ^{257}Rf from Sulfuric Acid with TOA in the SISAK system

Liv Stavsetra¹, J. Alstad¹, C. E. Düllmann², L. M. Farina², C. M. Folden III², S. H. Gallaher²,
K. E. Gregorich², D. C. Hoffman², M. Mendel³, H. Nitsche¹, D. Polakova¹, J. M. Schwantes²,
G. Skarnemark⁴, R. Sudowe², S. Yogarajah¹, R. E. Wilson², P. Zielinski², L. Zheng¹ and J. P. Omtvedt¹.

¹ Department of Chemistry, University of Oslo, P.O.Box 1033, Blindern, N-0315 Oslo, Norway

² Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720

³ Institut für Kernchemie, Universität Mainz, Fritz-Strassmann-Weg 2 D-55128 Mainz, Germany

⁴ Department of Materials and Surface Chemistry, Chalmers University of Technology, SE-412 96 Göteborg, Sweden

The fast, continuous liquid-liquid extraction system SISAK [1] was coupled to the Berkeley Gas-filled Separator (BGS) to study the extraction of Rf. ^{257}Rf was produced in the reaction $^{208}\text{Pb}(^{50}\text{Ti},n)^{257}\text{Rf}$ and separated in the BGS. The ions were then transferred to a KCl/He gas-jet in a Recoil Transfer Chamber [2]. The gas-jet transported the Rf atoms through a 20-m capillary to the SISAK system.

^{257}Rf was dissolved in 0.5 M H_2SO_4 and extracted into 0.02 M Tri-n-Octyl-Amine (TOA) in toluene. This chemical extraction system has been investigated for the Rf homologues Hf and Zr at the Oslo Cyclotron Laboratory [3]: The two homologues exert different behaviour in this system, and it is a promising system for chemical studies of rutherfordium in the liquid phase. Therefore, this system is well suited to explore the chemical properties of Rf in aqueous phase, as it will be possible to distinguish between Zr- and Hf-like properties.

The SISAK set-up is shown in Figure 1. A significant change compared to earlier SISAK experiments is the addition of a small mixer in front of the extraction centrifuge. This prolongs the contact time between the phases before separation. Thus, conditions closer to equilibrium are achieved and on-line results can be compared to ordinary extraction results using a separation funnel. To compensate for the increased transport time due to the mixer, the organic phase is added to the aqueous phase immediately after the latter exits the degasser. This doubles the volume, and hence the transport speed, through the capillary between the degasser and extraction centrifuge.

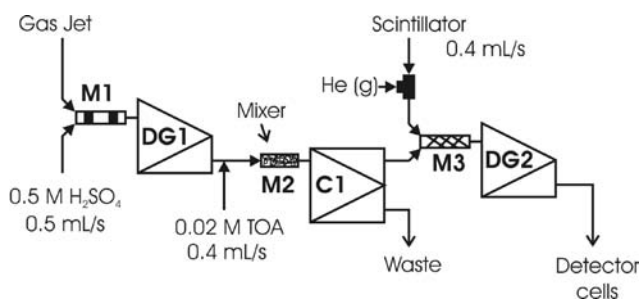


FIG. 1: SISAK set-up. In mixer M1 ions attached to the KCl particles in the carrier gas are transferred to the aqueous phase. The "degasser" DG1 separates the gas and liquid. Organic phase is then added and the liquid-liquid extraction occurs in mixer M2. The two phases are then separated in C1. In M3 scintillator and He gas are added to the organic phase. The He gas and any O_2 in the solution is removed by DG2, which also pumps the solutions through the detector cells.

The detection system was configured to wait for time-correlated α -particles from ^{253}No after each possible ^{257}Rf α . We observed seven $\alpha\alpha$ -correlations, as shown in Figure 2. The two low-energy points are most likely daughter-granddaughter correlations. Based on the number of correlations and amount of activity detected without performing an extraction, a distribution ratio $4_{-3}^{+\infty}$ can be estimated for the given concentrations.

This experiment indicates that Rf is extracted in the same manner as its homologues Zr and Hf. Zr has a distribution ratio a factor of 5-6 higher than Hf. Further experiments with this system are in preparation.

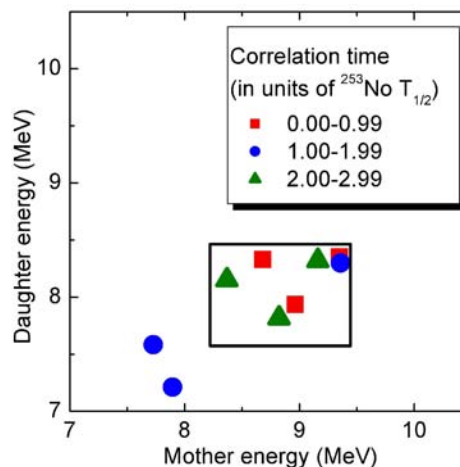


FIG. 2: Observed $\alpha\alpha$ -correlations. The square shows where ^{257}Rf - ^{253}No correlations are expected. (No points are hidden behind the legend box.)

References

- [1] J. P. Omtvedt et. al., J Alloys Compd **271**, 303 1998.
- [2] U. W. Kirbach et. al.; "The Recoil product Transfer Chamber (RTC): A new interface for heavy element chemistry studies at the Berkeley Gas-filled Separator", LBNL Annual Report 1999.
- [3] D. Polakova et. al.: "Extraction of Zr and Hf from Sulfuric Acid by Tri-Octyl-Amine using the SISAK System", SISAK Oslo Group Annual Report 2003, University of Oslo.